International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 7, Issue 6, Dec 2017, 163-170

EXPERIMENTAL RESULTS OF COCONUT SHELL POLYMER MATRIX COMPOSITES

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ABSTRACT

Composite materials are made from natural and eco friendly materials. These types of materials are used in agricultural straws and coconut shell. When using intermediate material like filler, due to changes in thermal stability properties is good, when compared to other agricultural waste. Epoxy polymer matrix, containing with coconut shell as filler up to 10 Wt%. Glass fibre laminates with filler was also studied. A result for all the 90 degree laminate strength, shows increment that means addition of filler, hardens the resin and improves the strength of the resin. Optimum Wt% for coconut filler is 2.5% and teak wood is 1%, % of change in strength 18.69% and 20.58%, respectively. In the case of 0 o laminate this will give the filler effect with fiber for coconut shell 1% and 2.5% shows increment in strength, % of change in strength 5.75%and 10.06% respectively.

KEYWORDS: Polymer Matrix, Bio Fillers, Coconut Shell Powder & Matrix Properties

Received: Oct 01, 2017; **Accepted**: Oct 20, 2017; **Published**: Nov 06, 2017; **Paper Id.**: IJMPERDDEC201717

Original Article

SCOPE OF THIS PROJECT

- To determine the flexural and tensile strengths of the Epoxy mixed with Coconut shell filler for various percentages. By making resin specimens.
- To find the optimum percentage of coconut shell filler in epoxy.
- To determine the flexural and tensile strengths of Epoxy laminate containing Coconut shell powder, Teak wood fillers separately mixed at a specific percentage.

INTRODUCTION

In recent decades, composites are used in applications such as in automotive, aerospace, marine, construction, and high performance applications due to their high specific modulus and strength, dimensional and thermal stability and low density. The use of fillers as third phase in composites has substantial interest in recent years, because of the advantages offered by modern nanotechnologies like production and cost reduction. The use of particles into thermo set polymer will improve the following properties like strength and toughness of composite materials, stiffness of the matrix and leading to the enhancement of the Young's modulus, and increase in tensile and flexural strength and other properties like compressive strength, impact strength glass transition temperature, and fiber–matrix interface at high temperatures.

Composition of Composite Material

Table 1.1: Chemical Composition of Coconut Shell

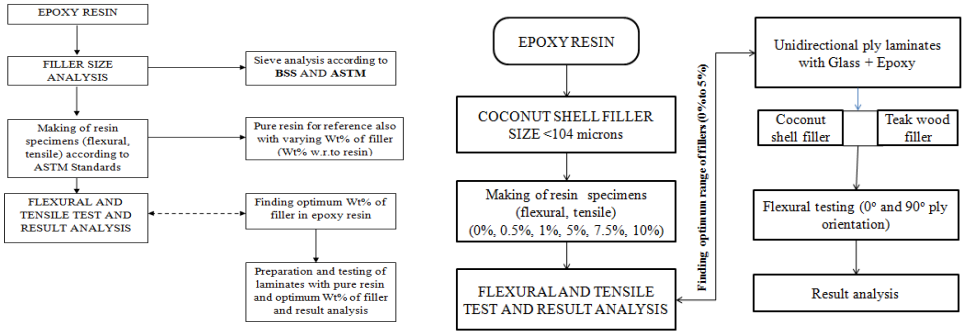
Composition	Wt%
Lignin	29.4
Pentosans	27.7
Cellulose	26.6
Moisture	8
Solvent Extractives	4.2
Uronic Anhydrides	3.5
Ash	0.6

Figure 1: Coconut Shell Powder

METHODOLOGY

MATERIALS AND TOOLS USED

Epoxy Resin LY 556, Hardener HY 951, Coconut shell filler, Glass fiber, sieve shaker, stirrer, Metal molds Acetone, Mansion Polish (Wax), Vernier Caliper, Roller, Brush, Digital Weighting Machine, Weights (12 Kg), Gloves and Mask.



MOLDS USED

The vertical mold is prepared, by milling out an aluminium bar, as per the ASTM standards for flexural testing (140mm *25 mm* 5mm) and tensile testing (340mm *25 mm*5mm).

Figure 2.2: Flexural Test Specimen Mold.

Figure 2.2.2: Tensile Test Specimen Mold

PREPARATION OF EPOXY RESIN SPECIMEN

The weight of Epoxy Resin needs to be measured according to the requirement of the shape of the specimen. Usually, the weight of Hardener is 10% of that of the weight of Epoxy Resin. The weight of coconut shell in the Wt% of Epoxy Resin is measured and mixed with the hardener. The prepared aluminum mold is opened by removing the nuts and bolts. Mansion Polish (Wax) has to be applied on the sides of the mold in order to obtain a smooth finish and make it unstuck to the resin mixture. The Hardener + Filler mixture is then added to the measured Resin and stirred until the mixture is completely mixed, usually 5-7 min. This process is Exothermic in nature. Then, the Mixture needs to be poured into the pockets, in the mold coated with wax. It is allowed to set for 24 hours, to achieve curing of the specimen.

Tensile and Flexural Test Specimens

Figure 2.4.1: Tensile Test Specimens

Figure2.4.2: Flexural Test Specimens

EXPERIMENTS AND RESULTS

TENSILE TEST

This test process involves fixing the specimen in fixture and applying tension displacement by crosshead until fracture occurs.

- The crosshead speed was maintained at a rate of 0.5 mm/min
- Span length of the specimen = 160 mm

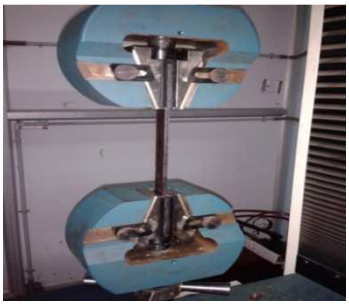


Figure 3.1.1: Tensile Test Fixture

FLEXURAL TEST

The specimens are subjected to 3 point bending and maximum deflection and ultimate stress is found out.

- The crosshead speed was maintained at a rate of 1 mm/min
- Support Span length of the specimen = 100 mm

Figure 3.2.1: Flexural test fixture.

RESULTS AND DISCUSSIONS

In this study, emphasis was given to tensile and flexural testing of epoxy, mixed with coconut shell filler of size 104 Microns and laminates, with coconut shell and teak wood fillers. Resin specimens are made, as per ASTM standards, by using the metal mould. Tensile and flexural test carried out at cross head speed of 0.5 mm/min and 1 mm/min, respectively results are discussed below.

TENSILE TEST RESULTS

Tensile test was conducted. In testing specimens, the parameter varied was the filler Wt percentage. Specimen with 0%, 1%, 5%, and 7.5% 10% filler Wt% were subjected to tensile test.

Table 4.1.1: Tensile Test Data

S.No	Wt% Of Coconut Shell Filler	Ultimate Stress (Mpa)	Strain at Time of Break %	%of Change In Strength W. R. to Pure Resin
1	0	27.35	1.925	Reference
2	1	36.1	3.431	31.99269
3	5	34.3	3.331	25.41133
4	7.5	30.7	3.056	12.24863
5	10	23.7	1.203	-13.3455

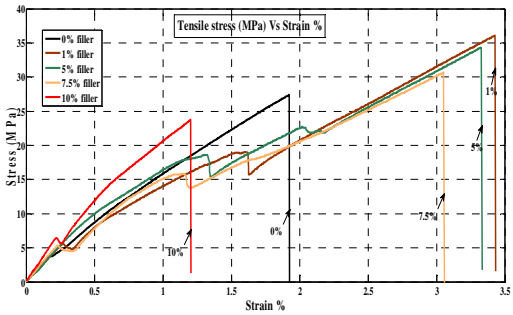


Figure 4.1.1: Tensile Stress (Mpa) Vs Tensile Strain %

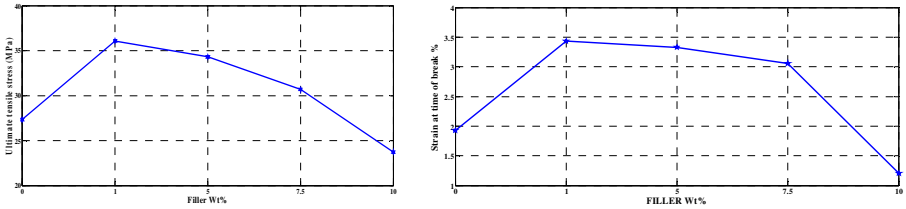


Figure 4.1.2: Ultimate Tensile Stress (Mpa) Vs Filler Wt % & Strain at Time of Break % Vs Filler Wt %

FLEXURAL TEST RESULTS

Flexural test was conducted. In testing specimens the parameter varied was the filler Wt% percentage. Specimen with 0%, 1%, 5%, and 7.5% 10% filler Wt% were subjected to Flexural test.

Table 4.2.1: Flexural Test Data

S. No	Wt% of Coconut Shell Filler	Ultimate Stress (Mpa)	Strain at Time of Break %	%of Change in Strength W. R. To Pure Resin
1	0	45.8	1.42	Reference
2	1	35.2	1.11	-23.1441 %
3	5	35.6	1.41	-22.2707 %
4	7.5	34.6	1.26	-24.4541 %
5	10	26.6	1.09	-41.9214 %

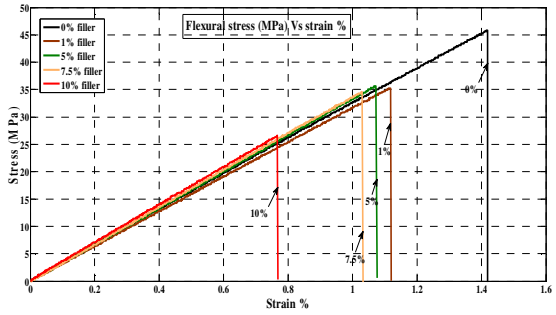


Fig 4.2.1: Flexural Stress (Mpa) Vs Flexural Strain %

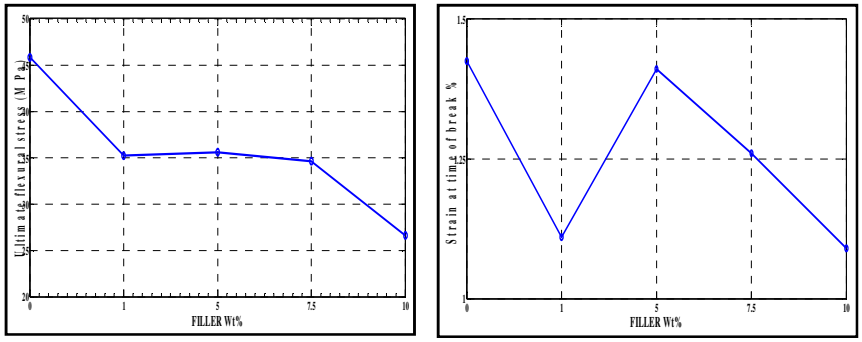


Figure 4.2.2: Ultimate Flexural Stress (Mpa) Vs Filler Wt %

& Strain At Time of Break % Vs Filler Wt %

COMPARISON OF ULTIMATE STRENGTHS VS FILLER WT%

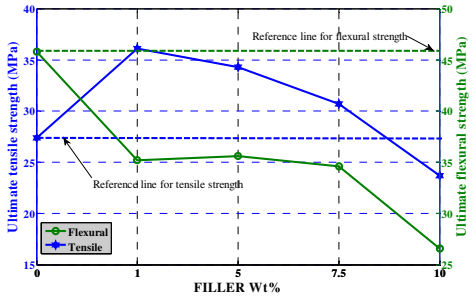


Figure 4.3.1: Ultimate Strengths (Mpa) Vs Filler Wt %

Addition of filler shows increase in tensile strength and reduction in flexural strength. Tensile strength is

maximum, for 1% addition of filler and further addition of filler, leads to decrease the strength. At 10 % addition of filler tensile strength is lower than the pure resin. (Reason of increase in tensile strength is due to good interfacial bonding between the hydrophilic filler and the hydrophobic matrix polymer and addition of filler delays the matrix cracking for particular % of filler). Flexural strength is lower than pure resin, for all % of filler. From flexural test results, it's seen that, deflection and strain value in bending decreases, as increase in filler % (Reason for reduction in flexural strength may be due to compressive characteristics of pure resin with filler is not effective.)

CONCLUSIONS

This study inspected the feasibility of utilizing of grain by-products, such as coconut shell, as alternative fillers in polymer composites material. The tensile and flexural properties of epoxy composites, reinforced with coconut fillers have been studied. It can be concluded from the studies that, the resin specimen with coconut shell filler showed improved tensile strength, upto 7.5% with decrease of the flexural strength. After the 7.5% of filler, both flexural and tensile results showed steep decrease in stress and strain, at 10% strength which is lower, when compared to mechanical properties of pure epoxy resin. It clearly indicates that, addition of coconut shell particle filler, improves the load bearing capacity of the composites. The increment in tensile strength is due to the better-increased surface area of filler, in the matrix. As the filler loading increased, thereby increasing the interfacial area, there was good interfacial bonding between the hydrophilic filler and the hydrophobic matrix polymer, which leads to increase in the tensile strength, upto certain percentage of filler.

In tensile and flexural testing, specimens demonstrated linear behaviour, with sharp fracture. Tensile strength of Epoxy with coconut shell filler is increased for 1%, 5%, 7.5% as 31%, 25%, 12%, respectively, compared to pure epoxy specimen. Coconut shell filler, upto 5% shows reasonable increase in tensile strength. So, from results we can infer that, the range of filler that is upto 5 % can be used, for third phase material (filler material) in fiber reinforced laminates. In glass fiber reinforced laminates, results for 90^{o} laminates shows strength, improved for all filler Wt % coconut shell filler 1%, 2.5%, 5%, 2.5% big size, and teak wood with 1% and 2.5%. The change in % of strength are 4.41%, 18.69%, 8.61%, 5.04%, 20.58%, 6.30%, respectively. And in 0^{o} laminate, only coconut shell filler 1% and 2.5% shows increment. The change in % of strength is 5.74%, 10.06%, respectively; rest of all Wt % shows decrement in strength. Finally, optimum percentage of coconut shell filler is 2.5% and coconut shell fillers are more effective, comparing to teak wood filler.

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